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(54) Title of the Invention: **Disk Cache Device**

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(72) Inventor: Yukie Yamazaki
(72) Inventor: Yuji Shimada
(72) Inventor: Yasuo Hatchi
(72) Inventor: Yoshito Suzuki
(71) Applicant: Hitachi, Ltd.
(71) Applicant: Hitachi Micro Software Systems K.K.
(74) Agent: Katsuo Ogawa, Patent Attorney (and one other)

SPECIFICATION

1. **Title of the Invention**

Disk Cache Device

2. **Claims**

1. A disk cache device, comprising a magnetic disk, a cache memory, and a controller for controlling said magnetic disk and cache memory, wherein said disk cache device is characterized by the fact that said controller determines whether or not said cache memory contains data for which an access request has been received from a host computer, actuates the spindle motor of said magnetic disk only when [said data] are not present in said cache memory, and again stops said spindle motor after access to said magnetic disk has been completed.

2. A disk cache device as defined in Claim 1, characterized by the fact that said controller stops the operation of the spindle motor of said magnetic disk when said cache memory contains data for which an access request has been received from said host computer.

3. A disk cache device as defined in Claim 1 or 2, wherein said spindle motor of said magnetic disk is not switched between operation and stoppage when the hit rate is lower than a separately determined value.

4. A disk cache device as defined in Claim 2, wherein said controller actuates said spindle motor of said magnetic disk when data for which an access request has been received from said host computer are not present in said cache memory.

3. **Detailed Description of the Invention**

Field of Industrial Utilization

The present invention relates to a disk device having a cache memory.

As described in the conventional examples cited in the DRPO 40C product specifications for hard disks manufactured by Alps Electric, commands for placing a magnetic disk in a low power consumption mode (and thus to lower the power consumption of the magnetic disk device) have in the past been issued by a host computer. An alternative has been to allow a magnetic disk itself to automatically switch to a low power consumption mode when no commands have been received by the magnetic disk over a predetermined period of time.

Problems Which the Invention Is Intended to Solve

With the aforementioned prior art, no consideration was given to the power consumption of a magnetic disk having a disk cache, and no provisions were made for reducing the power consumption of such magnetic disks. For a magnetic disk having a disk cache, however, a request for accessing the disk from the host computer (even when such a request is made) does not require accessing the disk while the corresponding data are held in the cache memory, that is, while a hit is made, and the power consumed by the disk in this period is wasted. It is therefore desirable to place the disk in a low power consumption mode when the requested data have been hit, even if an access request has been received from the host.

It is, however, impossible for the host computer to determine whether the requested data have been hit or missed, so the host computer cannot place the disk in a low power consumption mode when the requested data are hit, and electric power is wasted.

An object of the present invention is to lower the power consumption of a magnetic disk device having a disk cache.

Means Used to Solve the Above-Mentioned Problems

Aimed at attaining the stated objective, the present invention involves actuating a magnetic disk only when the cache memory does not contain the data requested by the host (when a miss occurs) and the magnetic disk is accessed, and placing the magnetic disk in a low power consumption mode under all other conditions. Specifically, the magnetic disk is

switched between different modes of operation by a magnetic disk controller independently of the host computer.

As used herein, the term "low power consumption mode of a magnetic disk" refers either to a mode in which power supply to ENDEC, an R/W circuit, or another signal processing circuit has been cut and the spindle motor of the disk stopped, or to a mode in which power supply to a signal processing circuit has been cut, but the spindle motor continues to operate.

Effect of the Invention

Because the magnetic disk controller controls the cache memory, it is clear whether or not the data requested by the host have been hit or missed. The fact that the magnetic disk controller switches the magnetic disk between an operating mode and a low power consumption mode makes it possible to place the magnetic disk in the low power consumption mode when the data have been hit.

Practical Examples

A practical example of the present invention will now be described with reference to figures.

Figure 2 is a block diagram of the hardware pertaining to a practical example of the present invention.

In Figure 2, **201** is a host computer, **202** a host interface controller, **203** a disk/cache memory controller, and **204** a cache memory.

An encoder/decoder data separator **(205)**, a waveform shaping circuit **(206)**, and an R/W circuit **(207)** are components of a signal processing circuit; the disk/cache memory controller **203** can control the feeding and cutting of power via power save control **2**.

210 is a spindle motor drive. The disk/cache memory controller **203** can control the manner in which a spindle motor **211** is switched on and off via the spindle motor drive **210** by means of power save control **1**.

A processing run performed in accordance with the present invention will now be described with reference to Figure 1. The processing starts with step **11**. In step **12**, the disk/cache memory controller **203** switches off the spindle motor **211** using power save control **2**. In conjunction with this, the power supply of the signal processing circuit is switched off using power save control **1**.

Next, in step **13**, the disk/cache memory controller **203** is held in a standby mode of low power consumption until a request is received from the host. As referred to herein, the low power consumption mode may, for example, involve stopping the input of clock [pulses] to the disk/cache memory controller, reducing the loss of electric power.

In step **14**, in which a request is received from the host, the disk/cache memory controller **203** cancels the low power consumption mode.

Next, in step **15**, the disk/cache memory controller **203** determines whether or not the data requested by the host have been hit or missed. In the case of a hit, data are exchanged between the cache memory and the host during step **16**. If a miss occurred during step **15**, the spindle motor **211** of the magnetic disk is switched on during step **17**, and power is fed to the signal processing circuit of the magnetic disk. In step **18**, data are exchanged between the host and the magnetic disk via the cache memory **204**, and in step **19** the spindle motor **211** of the magnetic disk is switched off again, and power is cut off from the signal processing circuit of the magnetic disk.

Another practical example will now be described with reference to Figure 3.

This practical example envisages preventing the spindle motor from being switched on and off with high frequency when the hit rate is low.

Steps **301** through **309** are the same as steps **11** through **19** in Figure 1. In this practical example, the disk/cache memory controller **203** determines in step **310** whether the hit rate has until now been high or low when the request from the host has failed to retrieve data during step **305**. Values serving as high and low reference levels should be separately preset, and the current hit rate compared with these numerical values.

If the hit rate is high, the same processing as in the practical example above will be performed. If the hit rate is low, the spindle motor **211** of the disk is switched on (if it has been switched off) in step **311**. Next, in step **312**, data are exchanged between the disk and the host via a cache memory **204**.

Merits of the Invention

Because the present invention involves operating the spindle motor of a magnetic disk only in the case of a miss, the loss of electric power is reduced, and power consumption can be lowered.

Another advantage is that because the spindle motor always operates when the hit rate is low, it is possible to reduce the time delay caused by the switching on and off of the spindle motor.

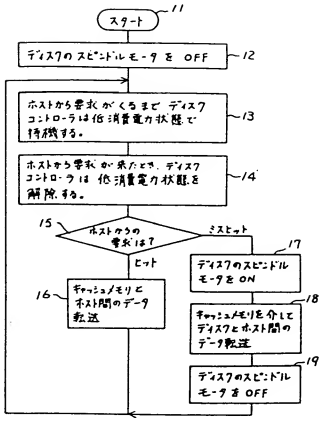
4. Brief Description of the Drawings

Figure 1 is a flow chart showing the processing performed in accordance with a practical example of the present invention, Figure 2 is a block diagram of the hardware [for carrying out the processing shown] in Figure 1, and Figure 3 is a flow chart showing the processing performed in accordance with another practical example of the present invention.

Key

203: disk/cache memory controller, **204**: cache memory, **205**: encoder/decoder data separator, **206**: waveform shaping circuit, **207**: R/W IC, **211**: spindle motor

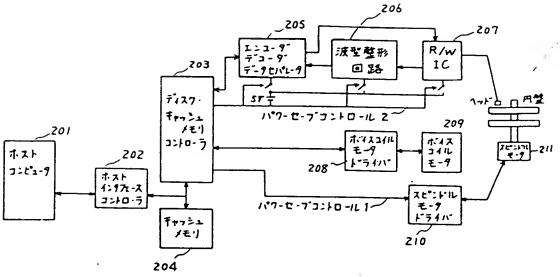
Figure 1



Key to Figure 1

11	Start
12	Disk spindle motor off
13	Disk controller maintains standby mode of low power consumption until request received from host
14	Disk controller cancels low power consumption mode when request received from host
15	Request from host?
(Below 15)	Hit
16	Data exchange between cache memory and host
(Above 17)	Miss
17	Disk spindle motor on
18	Data exchanged between disk and host via cache memory
19	Disk spindle motor off

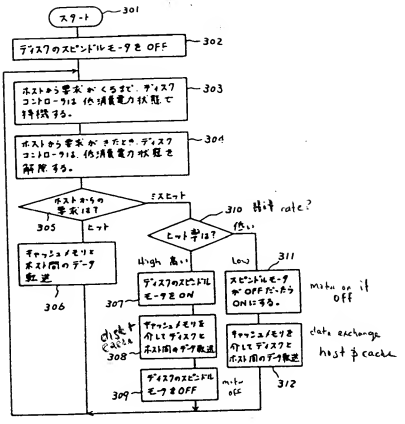
Figure 2



Key to Figure 2

201	Host computer
202	Host interface controller
203	Disk/cache memory controller
204	Cache memory
205	Encoder decoder data separator
206	Waveform shaping circuit
(Between 203 and 207)	[Power save control 2
(Above 211 to the left)	Head
(Above 211 to the right)	Disk
208	Voice coil motor driver
209	Voice coil motor
(To the left of 210)	Power save control 1
210	Spindle motor driver
211	Spindle motor

Figure 3



Key to Figure 3

301	Start
302	Disk spindle motor off
303	Disk controller maintains standby mode of low power consumption until request received from host
304	Disk controller cancels low power consumption mode when request received from host
305	Request from host?
(Below 305)	Hit
306	Data exchange between cache memory and host
(Above 310, to the right of 305)	Miss
310	Hit rate?
(Above 307)	High
307	Disk spindle motor on
308	Data exchanged between disk and host via cache memory
309	Disk spindle motor off
(Above 311, to the right of 310)	Low
311	Spindle motor switched on if previously off
312	Data exchanged between disk and host via cache memory

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審査請求　未請求　請求項の数 4　(全5頁)

(54)発明の名称　ディスクキャッシュ装置

(21)特　願　平2−328844

(22)出　願　平2(1990)11月30日

(72)発明者　山崎　雪絵　神奈川県横浜市戸塚区吉田町292番地　株式会社日立製作所マイクロエレクトロニクス機器開発研究所内

(72)発明者　島田　勇治　神奈川県横浜市戸塚区吉田町292番地　株式会社日立マイクロソフトウエアシステムズ内

(71)出願人　株式会社日立製作所　東京都千代田区神田駿河台4丁目6番地

(71)出願人　株式会社日立マイクロソフトウエアシステムズ　神奈川県横浜市戸塚区吉田町292番地

(74)代理人　弁理士　小川　勝男　外1名

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明　細　書

1．発明の名称

ディスクキャッシュ装置

2．特許請求の範囲

1．磁気ディスクと、キャッシュメモリと、前記磁気ディスクおよび前記キャッシュメモリを制御するコントローラとを備えたディスクキャッシュ装置において、

前記コントローラは、ホストコンピュータからアクセス要求があったデータが前記キャッシュメモリに存在するか否かを判別し、前記キャッシュメモリに存在しない場合のみ、前記磁気ディスクのスピンドルモータを動作させ、前記磁気ディスクへのアクセス終了後に、再び、前記スピンドルモータを停止させることを特徴とするディスクキャッシュ装置。

2．請求項1において、前記コントローラは、前記ホストコンピュータからアクセス要求があったデータが前記キャッシュメモリに存在する場合は、前記磁気ディスクのスピンドルモータの動作を止めることを特徴とするディスクキャッシュ装置。

3．請求項1または2において、ヒット率が別途定めた値よりも低い場合は、前記磁気ディスクの前記スピンドルモータの動作、停止の切り換えをしないディスクキャッシュ装置。

4．請求項2において、前記コントローラは、前記ホストコンピュータからアクセス要求があったデータが前記キャッシュメモリに存在しない場合に、前記磁気ディスクの前記スピンドルモータを動作させるディスクキャッシュ装置。

3．発明の詳細な説明

［産業上の利用分野］

本発明は、キャッシュメモリをもつディスク装置に関する。

［従来の技術］

従来、アルプス電気製ハードディスクDRPO40C製品仕様書に記載のように磁気ディスク装置の低消費電力化についてはこの公知例に記載のように、磁気ディスクを低消費電力状態にするコ

めて、電力の消費をおさえることである。

ホストから要求が来たときステップ１４で、ディスク・キャッシュメモリコントローラ２０３は低消費電力状態を解除する。

次に、ステップ１５で、ディスク・キャッシュメモリコントローラ２０３は、ホストから要求のあったデータがヒットしたかミスヒットしたかを判定する。ヒットしたときには、ステップ１６でキャッシュメモリとホスト間のデータ転送を行う。ステップ１５でミスヒットしたときには、ステップ１７で、磁気ディスクのスピンドルモータ２１１をＯＮし、あわせて、磁気ディスク中の信号処理回路の電源をＯＮする。そして、ステップ１８で、キャッシュメモリ２０４を介して磁気ディスクとホスト間のデータ転送を行い、ステップ１９で、再び、磁気ディスクのスピンドルモータ２１１をＯＦＦにし、あわせて磁気ディスク中の信号処理回路の電源をＯＦＦにする。

第３図を用いて、他の一実施例を説明する。

ータのＯＮ、ＯＦＦを制御に行わないようにするものである。

ステップ３０１～ステップ３０５までは、第１図のステップ１１～ステップ１９までと同じである。本実施例では、ステップ３０５でホストからの要求がミスヒットしたときディスク・キャッシュメモリコントローラ２０３はステップ３１０で、現在までのヒット率が高いか低いかを判定する。高いか低いかの基準となる値は別に決めておき、この数値と現在のヒット率とを比べればよい。

ヒット率が高いときは、前に述べた実施例と同じ処理を行う。ヒット率が低いときは、ステップ３１１でディスクのスピンドルモータ２１１がＯＦＦのときはＯＮにする。次に、ステップ３１２でキャッシュメモリ２０４を介してディスクとホスト間のデータ転送を行う。

［発明の効果］

本発明によれば、ミスヒット時のみ磁気ディスクのスピンドルモータを動作させるので、電力の消費が少なくなり、低消費電力化できる。

また、ヒット率が低い間は、スピンドルモータを常に動作させておくことができるので、スピンドルモータのＯＮ・ＯＦＦによる時間の遅れを軽減することができる。

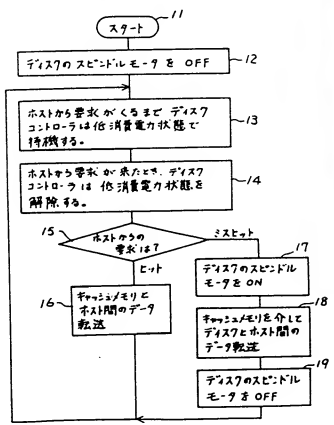
４．図面の簡単な説明

第１図は本発明の一実施例の処理を示すフローチャート、第２図は第１図のハードのブロック図、第３図は本発明の他の一実施例の処理を示すフローチャートである。

符号の説明

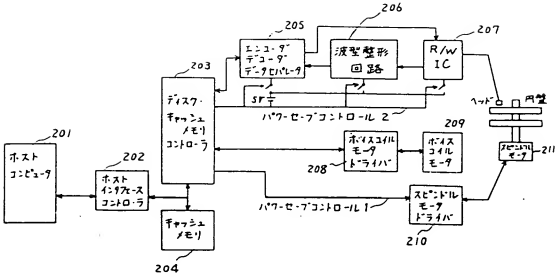
２０３…ディスク・キャッシュメモリコントローラ、２０４…キャッシュメモリ、２０５…エンコーダ・デコーダデータセパレータ、２０６…波型整形回路、２０７…Ｒ／Ｗ ＩＣ、２１１…スピンドルモータ。

第１図

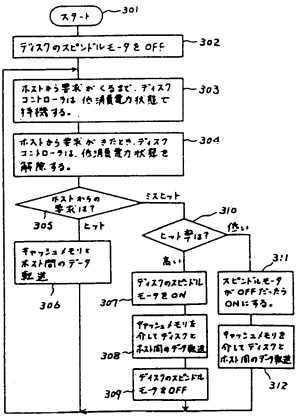


代理人弁理士　小川　勝男

第 2 図


201
ホスト
コンピュータ
202
ホスト
インタフェース
コントローラ
203
ディスク・
キャッシュ
メモリ
コントローラ
204
キャッシュ
メモリ
205
エンコーダ
デコーダ
データバッファ
206
波形整形
回路
207
R/W
IC
SFG
パワーセーブコントロール 2
ヘッド
円盤
209
ボイスコイル
モータ
ドライバ
208
ボイスコイル
モータ
211
スピンドル
モータ
パワーセーブコントロール 1
スピンドル
モータ
ドライバ
210

第 3 図


スタート
301
ディスクのスピンドルモータを OFF
302
ホストから要求がくるまで、ディスクコントローラは、低消費電力状態で待機する。
303
ホストから要求がきたとき、ディスクコントローラは、低消費電力状態を解除する。
304
ホストからの要求は？
305
ミスヒット
ヒット
ヒット率は？
310
低い
高い
311
キャッシュメモリとホスト間のデータ転送
306
ディスクのスピンドルモータを ON
307
スピンドルモータが OFF だったら ON にする。
キャッシュメモリを介してディスクとホスト間のデータ転送
308
キャッシュメモリを介してディスクとホスト間のデータ転送
312
ディスクのスピンドルモータを OFF
309